Variability of Heavy Precipitation by Long-Lived Mesoscale Convective Vortices Found in the Southern Plains

[1]Heather Vazquez and [2]Russ S. Schumacher
1 Department of Earth and Environment , Florida International University, Miami, FL
2 Department of Atmospheric Science, Colorado State University, Fort Collins, CO

Introduction

A Mesoscale Convective Vortex (MCV) is a low pressure center found within a Mesoscale Convective System (MCS). The structure of an MCV is comparable to that of a Tropical Cyclone as they favor weak to moderate vertical shear and are denoted by their cyclonic flow. Many times after the antecedent MCS dissipates, the MCV can assume its own identity and become the source for convection initiation the following day. When environmental conditions are favorable, an MCV can persist several days through multiple MCS cycles. Such a case is known as an MCV event.

Objective

To analyze favorable atmospheric conditions for long-lived MCVs that produced heavy precipitation against long-lived MCVs that produced little to no precipitation.

Data

- Observational Datasets for years 1979-2011 were collected from the NCEP North American Regional Reanalysis
- Grid Analysis Display System (GrADS) plotted Hovmöller analysis of relative vorticity and surface precipitation. (Fig. 1)

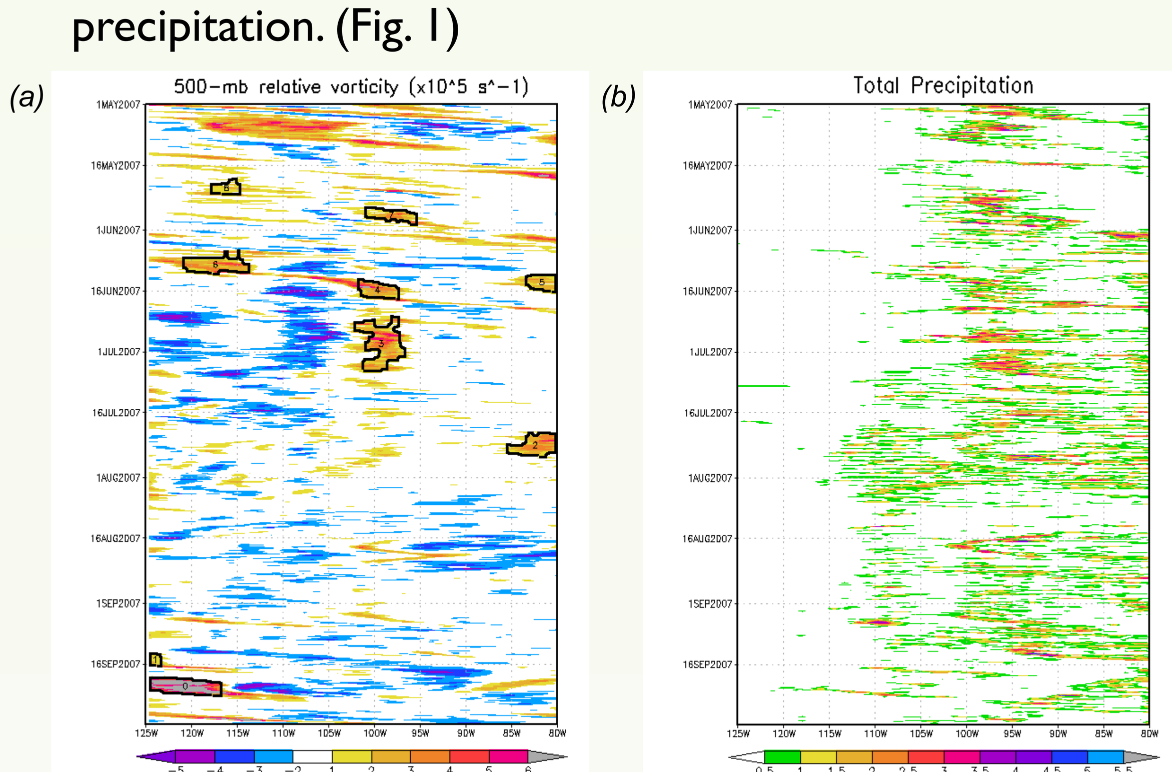

Fig. 1: (a) Relative Vorticity at the 500-mb level as a function of longitude and time. (b) 3-hour Total Precipitation at the surface as a function of longitude and time.

- Interactive Data Language (IDL) analyzed images from GrADS and created areas associated with long-lived cyclonic vorticity.

Methods

- Six cases were selected by their discernable quasi-stationary relative vorticity signatures lasting longer than four days.
- Precipitation correlation for each of the six relative vorticity signatures was also applied.
- Composite analysis of heavy precipitation cases and dry cases for multiple variables of the atmosphere.

Case Studies

Heavy Precipitation Cases:

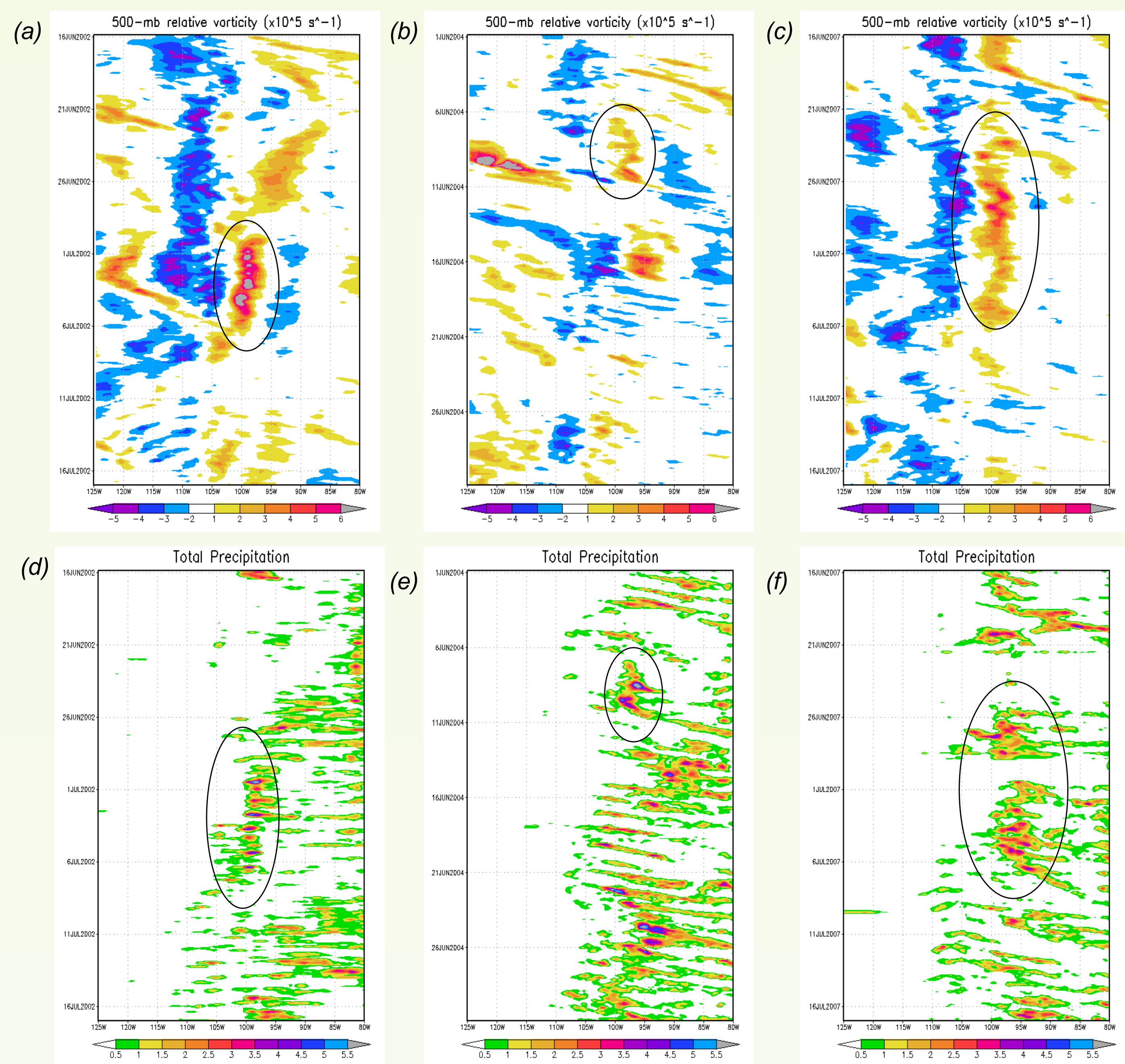

Fig.2: (a),(b),(c) Relative Vorticity at the 500-mb level as a function of longitude and time. (d),(e),(f) 3-hour Total Precipitation at the surface as a function of longitude and time.

Dry Cases:

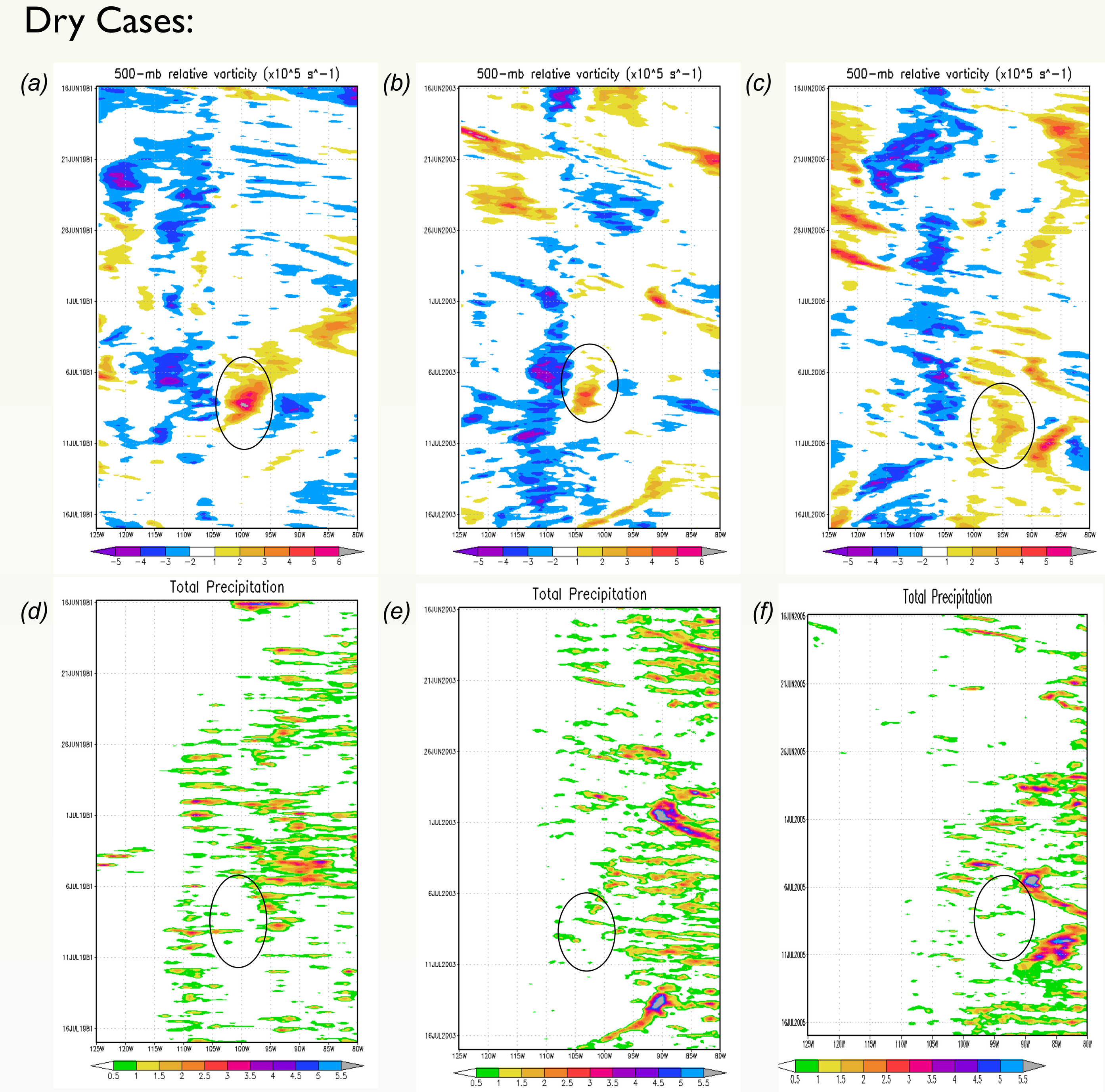

Fig.3: (a),(b),(c) Relative Vorticity at the 500-mb level as a function of longitude and time. (d),(e),(f) 3-hour Total Precipitation at the surface as a function of longitude and time.

Results

Heavy Precipitation Cases / Dry Cases

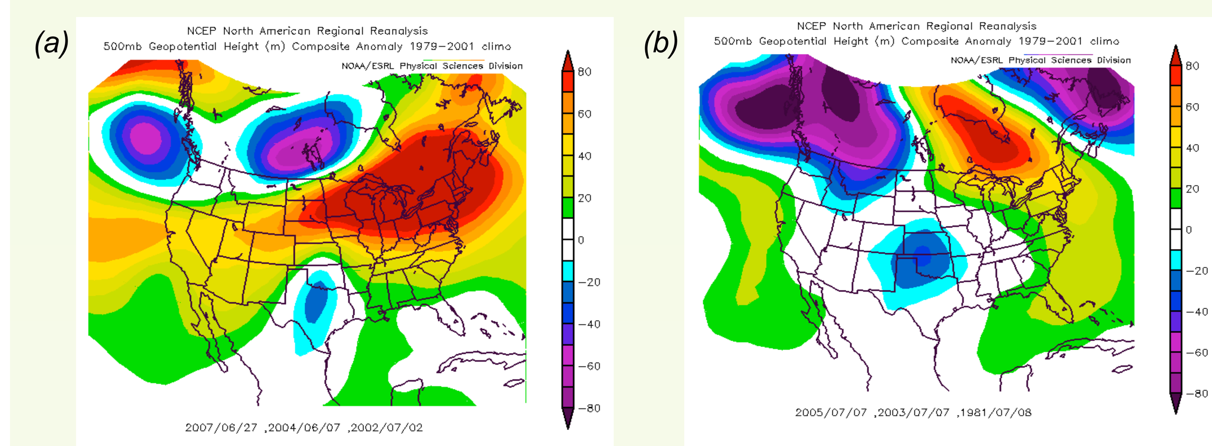

Fig. 4: 500-mb Geopotential Height Composite Anomaly (a) 27 June 2007, 7 June 2004, 2 July 2002 (b) 7 July 2005, 7 July 2003, 8 July 1981

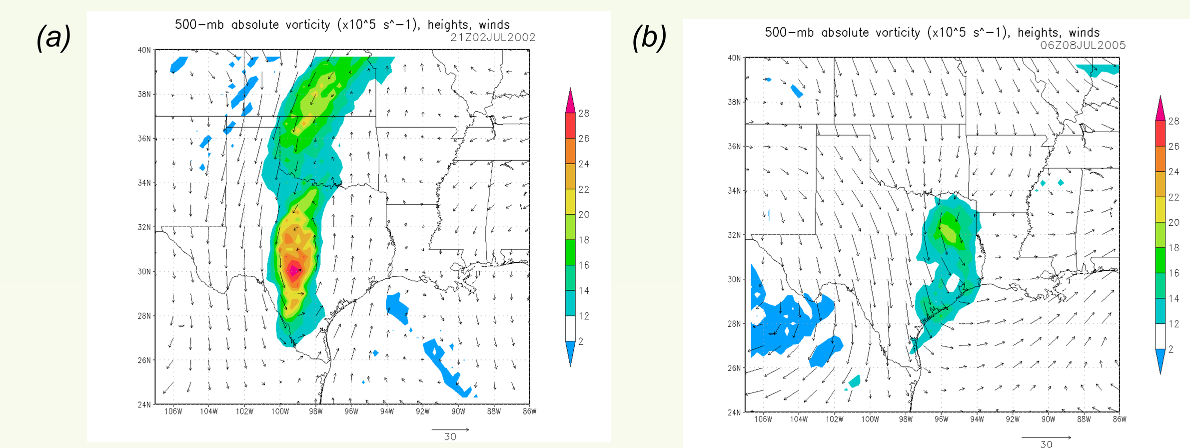

Fig. 5: 500-mb Absolute Vorticity, heights, winds (a) 2100 UTC 02 July 2002 (b) 0600 UTC 08 July 2005

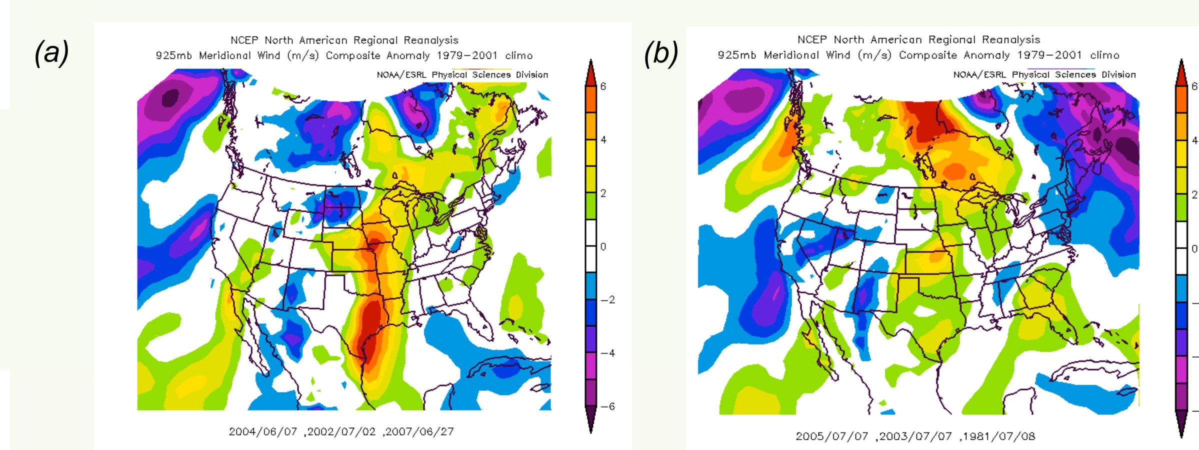

Fig. 6: 925-mb Meridional Wind Composite Anomaly (a) 27 June 2007, 7 June 2004, 2 July 2002 (b) 7 July 2005, 7 July 2003, 8 July 1981

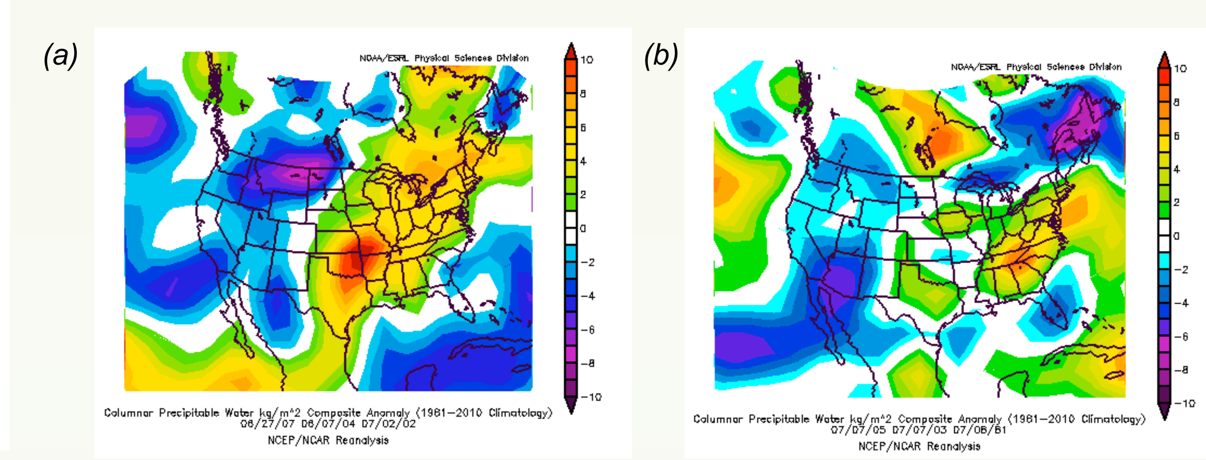

Fig. 7: Columnar Precipitable Water Composite Anomaly (a) 27 June 2007, 7 June 2004, 2 July 2002 (b) 7 July 2005, 7 July 2003, 8 July 1981

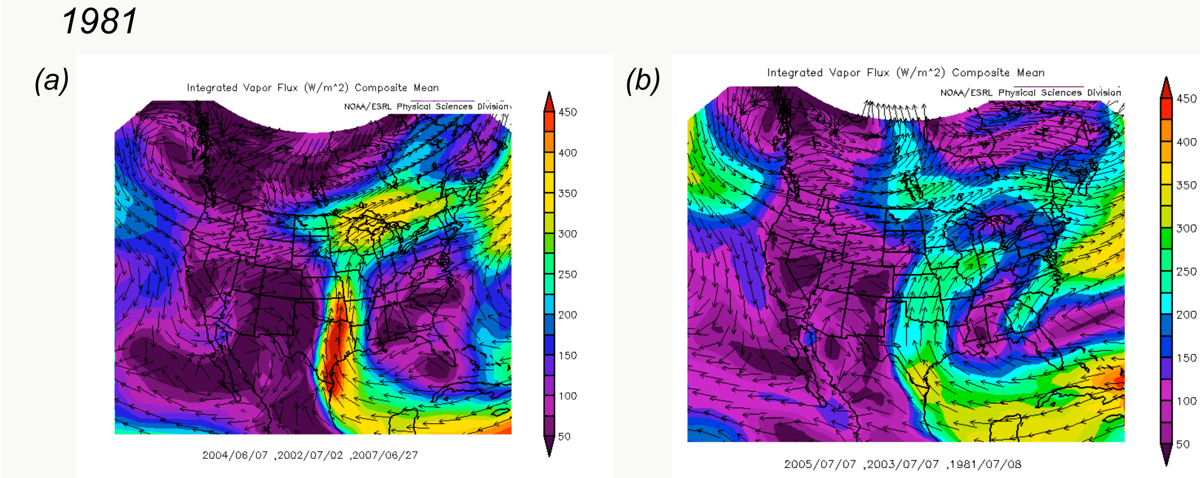

Fig. 8: Integrated Vapor Flux Composite Mean (a) 27 June 2007, 7 June 2004, 2 July 2002 (b) 7 July 2005, 7 July 2003, 8 July 1981

Results Continued

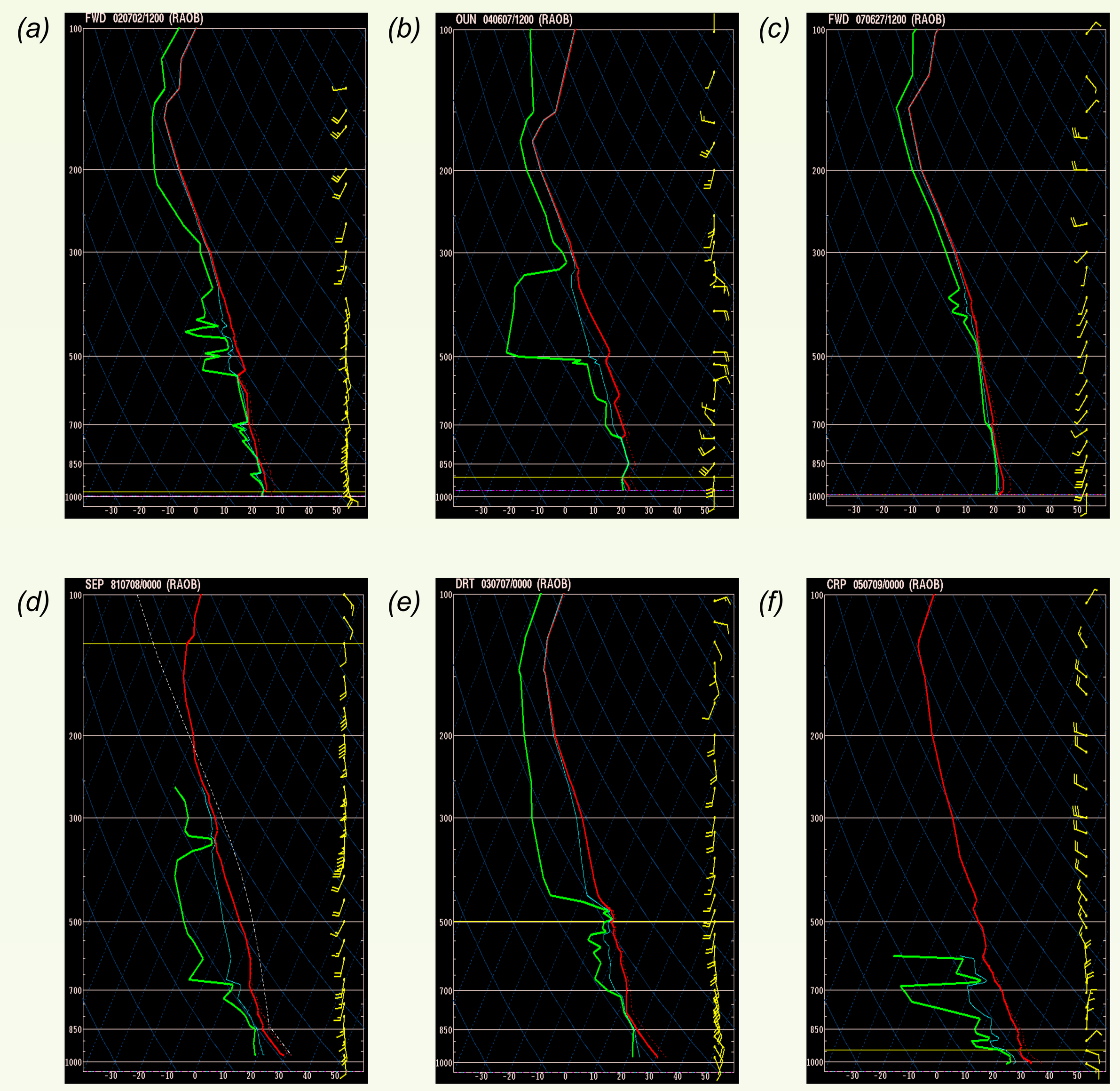

Fig. 9: Sounding Data (a) 1200 UTC 2 July 2002 (b) 1200 UTC 7 June 2004 (c) 1200 UTC 27 June 2007 (d) 0000 UTC 8 July 2007 (e) 0000 UTC 7 July 2003 (f) 0000 UTC 9 July 2007

Conclusion

- 500-mb Geopotential Height Composite Anomalies (Fig. 4) show a ridge displaced further south for heavy precipitation cases and uniform distribution of higher heights over the United States. Dry cases displayed a tighter ridge further north and larger gradients between lower and higher heights.
- Strong southerly flow is evident in the 925-mb Meridional Wind Composite Anomalies for cases with heavy precipitation. (Fig. 6a) This flow helped to loft moisture into the region from the Gulf of Mexico. (Fig. 7a)
- Sounding data (Fig. 9) confirms southerly flow and moist atmosphere for heavy rain events.

Future Work

- Look at additional cases to get a better in depth analysis
- Analyze different locations across the US.
- Investigate MCV structure to determine if warm or cold core lows may affect precipitation.

Acknowledgements

- Special thanks to Dr. Russ Schumacher, Samantha Lynch, Vanessa Vincente, and Charles Yost for their help and support.
- This work has been supported by the National Science Foundation Science and Technology Center for Multi-Scale Modeling of Atmospheric Processes, managed by Colorado State University under cooperative agreement No. ATM-0425247.